

Design Manual for Roads and Bridges



Llywodraeth Cymru
Welsh Government



General Principles & Scheme Governance
Inspection & Assessment

GS 952

Requirements for topographical surveys

(formerly MCHW Volume 5 section 1 Geodetic Survey: Parts 1 – 4 - SD12/96)

Version 1.0.0

Summary

This document contains the requirements for undertaking topographical surveys and provision topographical survey data supplementary to GG 951.

Application by Overseeing Organisations

Any specific requirements for Overseeing Organisations alternative or supplementary to those given in this document are given in National Application Annexes to this document.

Feedback and Enquiries

Users of this document are encouraged to raise any enquiries and/or provide feedback on the content and usage of this document to the dedicated Highways England team. The email address for all enquiries and feedback is: Standards_Enquiries@highwaysengland.co.uk

This is a controlled document.

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Latest release notes

Document code	Version number	Date of publication of relevant change	Changes made to	Type of change
GS 952	1.0.0	August 2021	Core document	Change to policy, major revision, new document development

This document replaces content in MCHW Volume 5 Section 1 Geodetic Survey: Parts 1 - 4, related to the definition of geodetic survey data for capture and delivery.

Previous versions

Document code	Version number	Date of publication of relevant change	Changes made to	Type of change
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Foreword

Publishing information

This document is published by Highways England.

This document supersedes relevant parts of MCHW Volume 5 Section 1 Geodetic Survey: Parts 1 – 4, related to the definition of topographical survey data for capture and delivery, which are withdrawn.

Contractual and legal considerations

This document forms part of the works specification. It does not purport to include all the necessary provisions of a contract. Users are responsible for applying all appropriate documents applicable to their contract.

Introduction

Background

This document contains the requirements for undertaking topographical surveys and provision of topographical survey data.

Topographical surveys being a type of geomatical survey, concerned with capturing an accurate representation of the land area and natural or man made features, as required by the use case.

This document contains requirements that apply regardless of the survey techniques used.

This document supplements the contents of GG 951 [Ref 1.N], with the addition of requirements specific to topographical surveys.

Assumptions made in the preparation of this document

The assumptions made in GG 101 [Ref 2.N] apply to this document.

Abbreviations

Abbreviation	Definition
LiDAR	Light detection and ranging

Terms and definitions

Term	Definition
Datum	A fixed starting point for scale measurements, typically used in reference to measuring height; that is, the location is a measured distance above or below a known datum level.
Light detection and ranging	A remote sensing technique, that uses laser emitters to map spatial positions and record the reflected wavelengths and intensity of light from objects in the scene.
Spatial accuracy	Stated accuracy declares that the survey data is within (+/-) a maximum tolerance of its real-world position. For each accuracy level there is a degree of confidence; the reliability that the observation adheres to the stated accuracy. Confidence is measured by the standard deviation from the mean, for example, 2 sigma = 95% confidence.
Survey area	The area of interest for which the topographical survey data is required
Survey bench mark	Physical marks made to record height above a known datum. Typically, they are found on buildings and other semi-permanent features, chiselled into hard surfaces.
Topographical survey	A type of geomatical survey concerned with capturing an accurate representation of the land, and natural or man-made features.
Trigonometrical station	A fixed surveying station used as a reference point for laying out survey control. Typically, a concrete pillar erected on the pinnacle of a hilltop or mountain to allow for connected sight lines between multiple stations.

1. Scope

Aspects covered

- 1.1 This document shall be used for the undertaking of topographical surveys and the provision of topographical survey data.

NOTE The requirements in this document apply regardless of the survey techniques used.

Implementation

- 1.2 This document shall be implemented forthwith on all schemes involving the undertaking of topographical surveys and provision of topographical survey data on the Overseeing Organisations' motorway and all-purpose trunk roads, according to the implementation requirements of GG 101 [Ref 2.N].

Use of GG 951

- 1.3 The overriding requirements contained in DMRB GG 951 [Ref 1.N] shall be followed in respect to all activities covered by this document.
- 1.4 This document shall supplement the requirements contained in GG 951 in defining the specific requirements for topographical surveys and topographical survey data.

Use of GG 101

- 1.5 The requirements contained in GG 101 [Ref 2.N] shall be followed in respect of activities covered by this document.

Use of GG 184

- 1.6 Where there is a requirement in this document to create, manage, or transfer topographical data, the requirements contained in GG 184 [Ref 3.N] shall be followed.

2. Deliverables

General

- 2.1 The requirements for deliverables defined in GG 951 [Ref 1.N] shall be applied to topographical surveys and the provision of topographical survey data.
- 2.2 The requirements detailed in this document shall supplement the deliverables as defined in GG 951 [Ref 1.N].

Survey report

- 2.3 The following information, as detailed by the requirements throughout this document, shall be included in the survey report:
- 1) topographical feature list;
 - a) feature definition;
 - 2) topographical data quality requirements;
 - a) completeness; and,
 - b) accuracy.

Survey data: topographical data

- 2.4 The topographical survey data deliverable shall be in accordance with the survey specification.
- 2.5 Topographical survey data shall be delivered in accordance with all relevant requirements within this document.

3. Topographical data and features

Topographical data

3.1 Topographical data shall only comprise geographic vector file formats or 3D polylines/linestrings, in accordance with the requirements within GG 184 [Ref 3.N].

NOTE Topographical data uses 2D or 3D points, lines, and polygons to represent the physical form of features, accompanied by associated metadata to differentiate feature types, and their granular detail.

3.2 All topographical data shall be in a format that facilitates its use and the reproduction of copies in necessary formats.

3.2.1 Use of proprietary formats and forms of presentation should be avoided.

3.3 Where the features surveyed extend up or down from ground level, separate layers shall be provided for the ground level lines and the other vertical extent.

NOTE For example, the tops of walls, fences, ditches will be in separate layers from their bases.

3.4 Features at ground level shall not cross except at a common point.

3.5 Features at ground level shall not be continuous across bridge decks.

3.6 Features at ground level shall stop and restart at the ends of the bridge deck.

3.7 Features that represent closed extents shall be geometrically closed.

3.8 Feature property information shall be provided as embedded attributes, not as unrelated data.

NOTE Feature information can include levels, references, and measurements.

3.9 Asset codes shall be as required by the Overseeing Organisation.

NOTE A list of current Highways England Asset Codes is available in table A.1 in GG 184

Feature listing

3.10 A feature list, of all feature types that are to be recorded in the topographical data, shall be in accordance with the survey specification.

3.10.1 An individual project may have a specific aim, and therefore constrain interest to a sub-set of the possible feature types.

NOTE For example, a renewals project for road restraint assets will have specific interest in these asset features (barrier types, end terminals, crash cushions) and carriageway features that influence their placement and function (such as, carriageway edges, kerbing, markings/lines, and adjacent structures). Many other features would be irrelevant to the purposes of the survey, and therefore would not be requested in the topographical data for delivery.

Benchmarks and trigonometrical stations

3.11 Where listed by the survey specification, survey benchmarks and trigonometrical stations shall be defined as individual features within the topographical data.

NOTE Survey benchmarks or trigonometrical stations will sometimes be present in the survey area; these features correspond to legacy or alternative referencing systems. They are not typically used by contemporary techniques to assure survey spatial accuracy, however recording these items can be valuable; linking the survey data to this reference, legacy control, and other historic data sets.

Temporary features

3.12 Where listed by the survey specification, temporary features shall be recorded in such a way to differentiate them from permanent features.

NOTE *Temporary features can include temporary signage, barrier, or other transient objects.*

Feature definition

3.13 The specific geometric definition of individual features shall be in accordance with the survey specification.

NOTE *Feature definition includes form, rules for their geometry and representation.*

3.14 For each feature, the following minimum requirements shall be defined:

- 1) name - unique, common, name for the feature;
- 2) description - text detail describing the nature of the feature;
- 3) hierarchy - any class or grouping the feature belongs to, multiple grouping levels can be used, including permanent or temporary features;
- 4) elements - sub-divisions of the feature that each correspond to a distinct feature in the topographical data, such as a kerb feature having separate elements for the kerb face and kerb top;
- 5) geometric form - for each feature/element the geometric form; for examples open/closed 3D poly-line, volumetric solid, point, and symbols;
- 6) geometric definition - for each feature/element a description detailing the position of the geometric line-work/vertices for the feature;
- 7) layer naming - in accordance with GG 184 [Ref 3.N]; and,
- 8) symbology - where required, the visual representation of the feature can be defined.

NOTE 1 *Item 3 (above): multiple grouping levels can be used, including permanent and temporary features.*

NOTE 2 *Item 4 (above): in the example, a kerb feature has separate elements for the kerb face and kerb top, which would be recorded in the topographical data.*

NOTE 3 *Item 8 (above): symbology can include specific line work, colour, and symbols used to define features in the topographical data.*

3.14.1 Additional requirements may be defined in the survey specification, unique to the implementation for certain feature types.

NOTE *To facilitate feature definition, Overseeing Organisations can provide existing (sample) data as an example, on which the specification can be based.*

Existing structures

3.15 Where any existing structure is among the features to be recorded, the feature definition shall be in accordance with the survey specification.

NOTE *Structures, such as bridges, gantries, culverts, and tunnels are typically complex, multi-component assets, and, as such, they can need more specific identification and definition for the survey in question.*

3.15.1 Feature definition may include specific dimensions or details to be recorded, such as:

- 1) span(s);
- 2) headroom(s);
- 3) clearance(s); and,
- 4) spot levels.

3.15.2 Feature definition may be unique for each structure type present or for each individual structure.

4. Topographical data quality

Survey completeness

4.1 The completeness requirement for the survey shall be defined in the survey specification.

NOTE *The completeness of the survey data set refers to the correlation between the recorded data area/objects and the true real-world area/objects. Required completeness is stated as a percentage. Where this is less than 100% an allowance is made for data to be incomplete up to a limit; for example a required completeness of 95%, indicates that up to 5% of the real-world data can be missing from the recorded data. Practically, this can be used to allow for reasonable error or omission when dealing with dispersed spatial areas and high numbers of feature objects.*

4.1.1 The completeness requirement may be selected for the whole topographical data set, or different completeness requirements may be selected for different feature types.

4.1.2 Any identified restrictions to the survey should be considered when evaluating completeness.

Spatial accuracy

4.2 The spatial accuracy requirement for the survey shall be defined in the survey specification.

4.2.1 The spatial accuracy requirement may be selected for the whole topographical data set, or different accuracy may be selected for different feature types.

NOTE 1 *The spatial accuracy of the survey data refers to the correlation between the recorded data object position and the true real-world object position. Required accuracy states that the survey data can be within (+/-) a maximum tolerance of its real-world position.*

NOTE 2 *For each spatial accuracy level there is a degree of confidence; that is the reliability that the observation adheres to the stated accuracy. Confidence is measured by the standard deviation from the mean; for example 2 sigma = 95% confidence - meaning 95% of all observations reliably fall within the stated accuracy. The standard deviations that are typically relevant to spatial accuracy are as follows:*

- 1) 1 sigma = 68% confidence;
- 2) 2 sigma = 95% confidence; and
- 3) 3 sigma = 99.7% confidence.

4.3 The spatial accuracy requirements shall be defined as in Table 4.3 below:

Table 4.3 Spatial accuracy bands

Band	Plan accuracy (X, Y)		Height accuracy (Z)		Description / Example
	1 sigma	2 sigma	Accuracy hard detail	Accuracy soft detail	
A	+/- 2 mm	+/- 4 mm	+/- 2 mm	+/- 25 mm	Best-achievable accuracy engineering planning/design and construction; mapping or movement-monitoring for critical features, such as structures.
B	+/- 4 mm	+/- 8 mm	+/- 4 mm	+/- 25 mm	High-accuracy engineering planning/design and construction; mapping or movement-monitoring for critical features.
C	+/- 5 mm	+/- 10 mm	+/- 5 mm	+/- 25 mm	General accuracy engineering planning/design and construction; mapping for hard features, such as pavement, kerbs, road restraint systems, buildings.
D	+/- 10 mm	+/- 20 mm	+/- 10 mm	+/- 25 mm	General accuracy engineering planning/design and construction; mapping both hard and soft features. High accuracy building, land, and boundary mapping; calculating lengths and areas.
E	+/- 25 mm	+/- 50 mm	+/- 10 mm	+/- 50 mm	Low-accuracy preliminary planning/design and validation; mapping both hard and soft features. General accuracy building, land, and boundary mapping; calculating lengths and areas.
F	+/- 50 mm	+/- 100 mm	+/- 50 mm	+/- 100 mm	Low-accuracy preliminary planning/design and validation; mapping both hard and soft features. Low-accuracy building, land, and boundary mapping; calculating lengths and areas.
XYZ	(Custom)		(Custom)	(Custom)	As required.

- NOTE 1* Height accuracy requirements for soft detail will not exceed +/-25 mm, regardless of increasing accuracy banding, due to the nature of these features; that is flexible or transient, with no consistent surface height.
- NOTE 2* Accuracy requirements apply to individual implementations of the survey. When combining or comparing data from distinct surveys (taken at different intervals, or using different techniques/equipment) there will typically be a decrease in the accuracy from a given data set, that is greater than or equal to the sum of the tolerance ellipsoids.
- 4.4 Where a custom spatial accuracy band is selected, planar and height accuracy shall be defined for desired sigma levels, as with Bands A-F.

Validation

- 4.5 All topographical data survey data (collected and processed) shall be checked and confirmed to be in accordance with the survey data quality requirements as above in this section before delivery to the customer for the survey.

5. Normative references

The following documents, in whole or in part, are normative references for this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Ref 1.N	Highways England. GG 951, 'General requirements for geometrical surveys'
Ref 2.N	Highways England. GG 101, 'Introduction to the Design Manual for Roads and Bridges'
Ref 3.N	Highways England. GG 184, 'Specification for the use of Computer Aided Design'

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